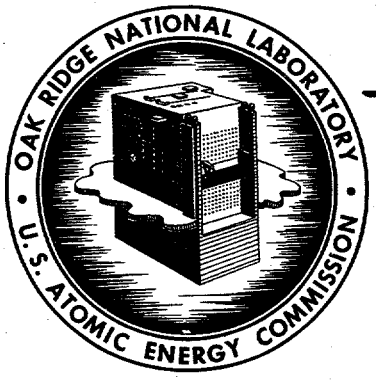
ORNL-2475
Health and Safety

LABORATORY STUDIES ON THE GROUND DISPOSAL OF ORNL INTERMEDIATE-LEVEL LIQUID RADIOACTIVE WASTES

R. L. Blanchard
B. Kahn
G. G. Robeck

1958



OAK RIDGE NATIONAL LABORATORY
operated by
UNION CARBIDE CORPORATION
for the
U.S. ATOMIC ENERGY COMMISSION

Table II

Composition of Random Sample of Pit No. 3 Overflow

Collected October 19, 1956

Ionic Composition		Radioactive Composition (1-30-57)	
Ion	Concentration	Radionuclide	Concentration
Na^{+}	14 mg/ml	Cesium	660 x 10^{-3} µc/ml*
Al^{+3}	0.29	Ruthenium	94 " "
K^{+}	0.15	Cobalt	7 " "
Si^{+4}	0.020	Antimony	4 " "
NH_3	0.002	Strontium	7 " "
Fe^{+3}	0.001	Rare earths and Yttrium	7 " "
NO_3^{-}	21	Zirconium	1 " "
OH^{-}	2.9	Niobium	13 " "
SO_4^{-2}	2.1	Gross α	240 c/m/ml
CO_3^{-2}	1.8	Gross β	132,000 c/m/ml
PO_4^{-3}	0.20	Gross γ	308,000 c/m/ml
Cl^{-}	0.18		
Ca^{+2}	0.075		
Total Solids 47.			

* Cesium-137, ruthenium-106, cerium-144, and strontium-90 have daughters in radioactive equilibrium; antimony-125, has a daughter which may be in radioactive equilibrium with its parent.

M-744

INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

Y/HG-0124

May 16, 1983

To: C. R. Richmond

From: T. W. Oakes T.W. Oakes

Subject: Literature Information on Mercury

As discussed by telephone on the afternoon of May 13, I have attempted to put together data pertinent to the information of mercury releases at Y-12. This information is provided in the attachments.

TWO:aw

xc: H. H. Abee

1. Get atmospheric levels along creek.
2. Characterize sediment samples as to metallic Hg methyl →
3. Feed sediment to rats for hazard study - inorganic mercury hazard from ingestion.
4. Analyze perimeter Hi-Vol filters for Hg.
5.

LEGISLATION AND RECOMMENDED LEVELS

THE JOINT F.A.O./W.H.O. EXPERT COMMITTEE ON FOOD ADDITIVES (1972)

- RECOMMENDED THAT FOR MERCURY, THE PROVISIONAL TOLERABLE WEEKLY INTAKE BE SET AT

  TOTAL MERCURY

  0.3 MG/PERSON

  0.005 MG/KG BODY WEIGHT

  METHYL MERCURY EXPRESSED AS MERCURY

  0.2 MG/PERSON

  0.0033 MG/KG

- THESE FIGURES RELATE TO INTAKE FROM ALL SOURCES INCLUDING FOOD DRINKING-WATER, AND RESPIRED AIR

THE WORLD HEALTH ORGANIZATION PROPOSED (W.H.O. 1971) AN UPPER LIMIT FOR MERCURY IN DRINKING-WATER OF

- 1.0 µG/L

  0.001 PPM BY WEIGHT

OCCUPATIONAL EXPOSURE

- THRESHOLD LIMIT VALUE (TLV) GIVEN BY ACGIH FOR ALL FORMS OF MERCURY OTHER THAN ALKYL COMPOUNDS IS
  - 0.05 MG/M^3
- TLV FOR ALKYL MERCURIC COMPOUNDS IS
  - 0.01 MG Hg/M^3

LEGISLATION AND RECOMMENDED LEVELS

WORLD HEALTH ORGANIZATION (1979)

0.025 MG/M^3 LONG-TERM EXPOSURE

0.5 MG/M^3 SHORT-TERM EXPOSURE NOT EXCEEDING 15 MIN.

EPA INTERIM PRIMARY DRINKING WATER REGULATION

0.002 MG/L

EPA CLEAN WATER ACT (P.L. 95-217) HG AND COMPOUNDS ARE HAZARDS

TENNESSEE WATER QUALITY STANDARD

50 PPB

FDA FISH STANDARD

1 PPM

RCRA STANDARD

*EXAMPLE NPDES PERMIT FROM STATE OF TENNESSEE

NPDES # TN0005444

TVA - JOHNSONVILLE STEAM PLANT

NO DISCHARGE FOR PCB

NPDES FOR HOLSTON ARMY AMMUNITION PLANT (KINGSPORT)

AREA A

HG - DAILY AVERAGE CONCENTRATION OF HG NOT TO EXCEED 0.005 MG/L

AREA B

DAILY AVERAGE CONCENTRATION HG NOT TO EXCEED 0.005 MG/L

INST. MAX. CONCENTRATION NOT TO EXCEED 0.05 MG/L

East Fork Poplar Creek (EFPC)*

	Max
Bluegill	3.6 ppm
Largemouth Bass	1.3 ppm
Rock Bass	0.87 ppm

Bear Creek (BC)*

Bluegill	0.51 ppm
Rock Bass	1.2 ppm

* From ORNL/CF-82/257

New Hope Pond
Max Sediment

NHP-14 302 ppm

East Fork Poplar Creek
Max Foliage

Live 0.23 ppm

Dead 6.9 ppm

SEDIMENT SAMPLING DATA *

U

1974	1006 ppm	1% U-235, 99% U-238
1974	163 ppm	in secular equilibrium with U-234

Th

1974	171 ppm	"Nat" 232 and 228
1974	37 ppm	[redacted]

Pu

Pu-238		Pu-239/-240	
1982	10 pCi/gm	1982	<5 pCi/gm
1982	<8 pCi/gm	1974	0.014 pCi/gm

Hg

1982	480 ppm
1982	240 ppm

PCB 1248

1974	0.6 ppm
1974	0.3 ppm

* Data from DoE

PHYSICAL AND CHEMICAL PROPERTIES

MERCURY IS THE ONLY METAL WHICH EXISTS IN THE LIQUID STATE BELOW $0^{o}C$.

ATOMIC WEIGHT OF 200.6

ATOMIC NUMBER OF 80

MELTING POINT -39.9 ^{o}C

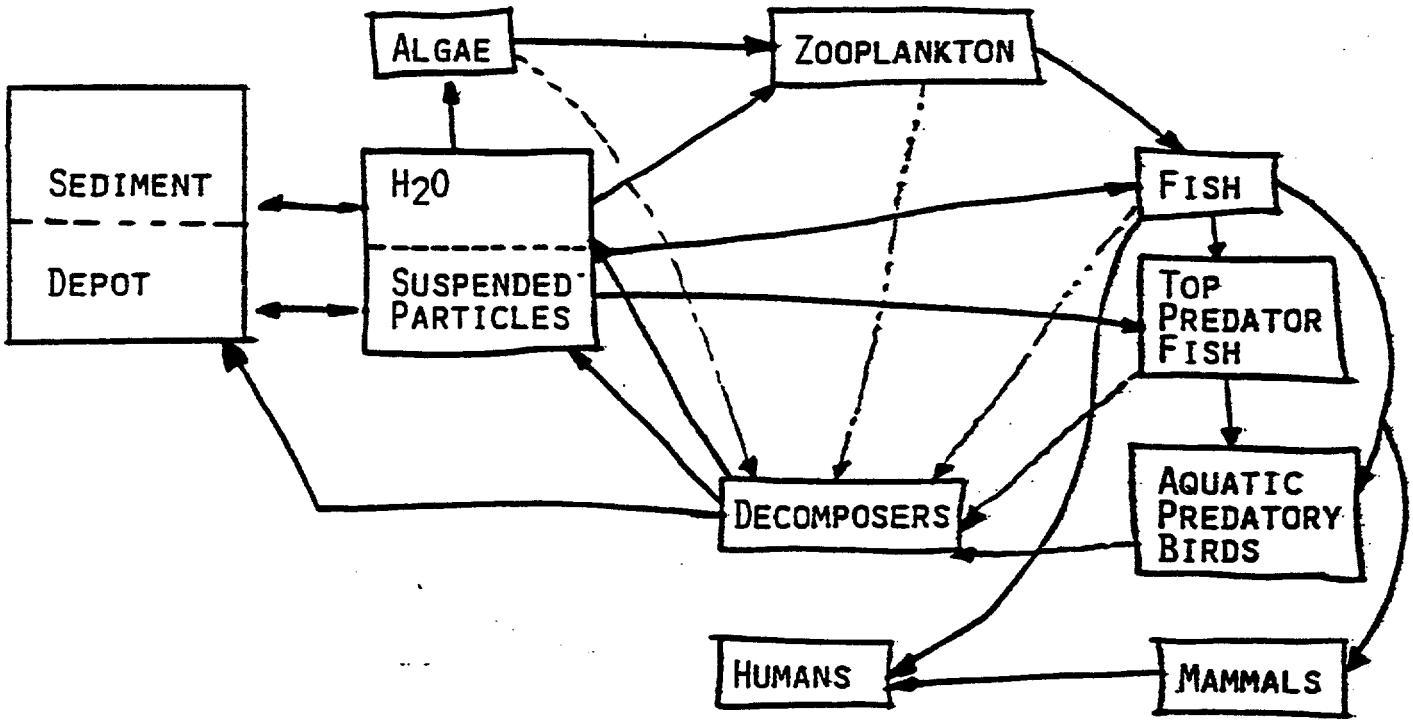
BOILING POINT 365.9 ^{o}C

OXIDATION OF MERCURY FORMS EITHER MERCUROUS OF MERCURIC VALENCE STATES

FORMS

- ELEMENTAL
- MERCUROUS AND MERCURIC SALTS
- MERCURY FORMS A GROUP OF ORGANOMETALLIC COMPOUNDS

FOOD CHAIN MODEL FOR MERCURY*



*HARTUNG, 1972 - ANN ARBOR SCIENCE PUBLISHERS

U.S. AVERAGE DATA*
(ppb)

	Soil Mean	Sediment	Drinking Water	Surface Water
Hg	0.071 ppm		<0.5 - <1.0 ppb	0.1-20 ppb
PCB		2.2-48.2		0.006-0.12

*EPA-600/45-82-030a, May 1982
Environmental Monitoring at Love Canal, Volume 1

The PCB water quality criterion is 0.001 µg/1 for the protection of aquatic life - quality criteria for water (EPA 1976)

Mercury Concentrations in Sediments of Rivers and Streams in North America

River	Max. Conc.	Source	Reference
St. Lawrence	0.18 ppm	Industrial	Johnston (1977)
Oswego	0.67 ppm	Industrial	Fitchko & Hutchinson (1975)
Ottawa	3.0 ppm	Pulpwood Mill	Rust & Waslenchuk (1974)
Islais (Creek)	6.9 ppm	Industrial	Smith (1972)
Stream in Taylor Mts. (Alaska)	10.0 ppm	Mining industry	Clark et al. (1970)
Tennessee River (North Fork)	32 ppm	Chlor-alkali industry	Derryberry (1972) Turner & Lindberg (1978)
St. Clair River	60 ppm	Chlor-alkali industry	Cline et al. (1973)
Detroit River	86 ppm	Chlor-alkali industry	Turney (1971)

CHEMICAL PATHWAYS

ALL FORMS OF MERCURY ARE SUBJECT TO CHEMICAL TRANSFORMATION IN THE NATURAL ENVIRONMENT.

METALLIC MERCURY IS OXIDIZED IN WATER TO THE DIVALENT MERCURIC ION Hg^{2+}

- MUCH OF THIS IS PRECIPITATED AS INSOLUBLE MERCURIC SULFIDE, ESPECIALLY IN AN AEROBIC ENVIRONMENTS WHERE HYDROGEN SULFIDE IS LIKELY TO BE PRESENT, ALTHOUGH EVEN THE INSOLUBE SULFIDE MAY BE OXIDIZED TO THE SULFATE, RELEASING THE MERCURIC ION AGAIN.

ANOTHER IMPORTANT REACTION MAY INVOLVE THE DIVALENT MERCURIC ION, A BIOLOGICAL PROCESS IN WHICH THE ION IS METHYLATED TO MONOMETHYL OR DIMETHYL MERCURY.

- JENSEN AND JERMELON (1969) SHOWED THAT SUCH METHYLATION MAY OCCUR IN THE SEDIMENTS OF FRESH WATER BY MEANS OF ANAEROBIC METHYL GROUP DONATING BACTERIA.

- SEVERAL BACTERIAL GENERA, FUNGI AND OTHER SPECIES ARE CAPABLE OF THIS METHYLATION REACTION, WHICH IS ENHANCED IN GENERAL BY CONDITIONS WHICH FAVOR MICROBIOLOGICAL ACTIVITY.

TOXIC TRACE METALS IN MAMMALIAN HAIR AND NAILS*

MERCURY

BLOOD	0.005 PPM
HAIR	1.5 PPM

REPORTED LEVELS IN HAIR - 0.01-2,436 PPM
NORMAL RANGE - 0.01-30.0 PPM
THRESHOLD EFFECTS - 50-200 PPM
ACUTE OR CHRONIC EFFECTS - 200-800 PPM
DEATH - 500 PPM(+)

METHYL HG IS HIGHLY TOXIC, MERCURY POISONING, MINAMATA DISEASE; CAUCSES CONGENITAL ABNORMALITIES. HIGH LEVELS OF HG IN HAIR HAVE BEEN CORRELATED WITH HG POISONING WITH SYMPTOMS OF BLINDNESS, CONVULSIONS AND DEATH.

EPA 600-/4-79-049 AUGUST 1979 D. W. TENKNI

UKITA (1968) AND AL-SHAHRISTANI AND AL-HADDAD (1972) CHARACTERIZED AVERAGED "NORMAL" LEVELS OF HG IN HAIR TO BE 4-6 PPM IN NORTH AMERICA